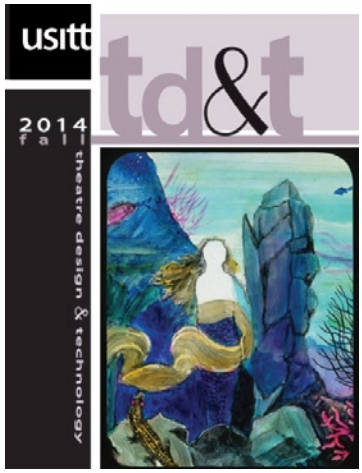

An Experiment with Digital Lighting in *Adding Machine: A Musical*

By Rana Esfandiary and Mark Reaney

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The business of workers in the theatre is, as I see it, to express a timeless theme by means of the tools of one's own time.

— Robert Edmond Jones

In November 2013 a new production of *Adding Machine: A Musical* by Joshua Schmidt and Jason Loewith was presented by the University Theatre at the University of Kansas. This production was the tenth in a series of experiments since 1995 in which virtual reality (VR) was used as the scenic medium. In each successive production a new technique or technology was tested for its effectiveness in theatrical production. In this production, the experiment was with real-time computer-generated lighting from digital projectors mounted in the front of house position. Virtual scenic elements were

Figure 1. Mr. Zero at the office. Note the animation clip of swirling numbers visible on the stage floor.

Figure 2. Mr. and Mrs. Zero at home in bed. Note the unique camera angle in the VR simulation that places them "lying down" while standing. Also note the silent movie footage visible on the stage floor.

created through the use of a computer and projector mounted behind a rear projection screen and functioned in a similar fashion to other VR productions that we have done in the past. This production was directed by Mechele Leon. The scenery, lighting, and VR technology were designed by Mark Reaney, the costumes by Rebecca Damren. Rana Esfandiary was in charge of creating the content for the digital lighting and programming its control.

The technology to be tested in this production was two pair of computers and digital projectors, one mounted house left, the other house right, from which lighting effects could be generated in real time using a series of recorded video sequences and real-time video manipulation software. The inspiration for this innovation came from some early work by Rob Shakespeare, who presented his results of a trial with digital projection lighting at the Virtual Scenography in Live Performance Symposium in 2006 at Indiana University, where he teaches.

The philosophy behind all of our VR experiments is that a bridge can be built between traditional theatre methods and the data-enriched environment to which our audiences are accustomed. By using digital media we are speaking directly to an audience that spends many hours per day accessing information on electronic devices such as computers, televisions, tablets, and smartphones. This is the language they are accustomed to speaking and the manner and pace in which they have trained themselves to absorb information. By contrast, traditional theatre of muslin, paint, and wood may seem comfortable, yet somewhat quaint and old-fashioned. The vast majority of the visual information that people receive on a daily basis is digitally produced or enhanced. Web pages, movies, television shows, even commercials, are created through the use of digital technology. Digital media adopted by the theatre therefore can present stories built for a modern audience and at a pace that keeps up with their imaginations. However, by using real-time computing methods, we are able to retain the live quality of theatre performance which makes it a unique art form.

From a practical standpoint, virtual scenery allows the visual field to change almost instantaneously. This fits with the cinematic style in which many modern plays are written. Digital scenography also allows for the creation of impressive visual effects without the excessive budgets and technologies employed by today's Broadway productions.

Our first experiment, Elmer Rice's *The Adding Machine* (1995), was an exercise in using the basic ideas of virtual reality as a scenic medium. This scenery was generated and manipulated in real time and projected in stereoscopic 3-D. The audience wore polarized glasses to view the projected scenery in three dimensions. By today's standards the technology was very rough. The computer was slow, the software rather crude, the images lacked detail, and the projectors were quite dim when compared to modern equipment.

The next experiment with a full-length play, *Wings* by Arthur Kopit (1996), was an adventure in which the audience all wore head-mounted displays in order to have the scenery projected in three dimensions directly before their eyes. In *Tesla Electric* (1998), we bypassed the real-time computing elements in favor of highly detailed, realistic still images which were again projected in 3-D in a 120-degree cyclorama format. While the widescreen format was very successful, the real-time computer effects were sorely missed.

Our fifth production, *Machinal* by Sophie Treadwell (1999), returned to real-time VR scenery. This time we were able to use new generation computers and software with much brighter projectors. The new twist in this production was the integration of live video elements coming from cameras trained on offstage actors and a staging that left the computer and projector operators visible to the audience at all times. *A Midsummer Night's Dream* followed in 2000, this time staged at the University of Kent at Canterbury. This production also used live video from cameras offstage, but in this case the cameras were rigged to capture video in stereoscopic 3-D to be sent to front-of-house positions and projected in 3-D. Again the audience wore polarized glasses to achieve the 3-D effect.

Our seventh VR production was a theatre for young audiences show entitled *Dinosaurus* by Edward Mast and Lenore Beninger (2001). In this production the scenery was not generated by computers, but the dinosaur characters were. Each dinosaur was manipulated by computer operators backstage using joysticks and keyboards. The effect was much like operating gigantic electronic puppets. In *The Magic Flute* (2003) we explored new ground by breaking away from the traditional projection screen/actor relationship. Throughout the production performers carried or wore small projection surfaces onto which scenic elements could be projected from the orchestra pit. Those projection screens, which were flown in from the loft, appeared in a variety of positions and were constructed in a variety of shapes and sizes.

Our ninth production, *The Tree of Life* (2009), was a specially conceived music and dance production. At this time we were able to take advantage of yet another new generation of software, computers, and projectors. Special effects such as wind and waves never before available to us were used in creating the virtual environments.

Adding Machine: A Musical

Elmer Rice's *The Adding Machine* is commonly held up as the prime example of expressionism in the American theatre. In it we witness Rice's critical view of modernization and racism that took over the United States of America during the early twentieth century. In adapting Rice's script, Joshua Schmidt and Jason Loewith created a short, haunting musical.

Adding Machine: A Musical is the story of an accountant, Mr. Zero, who after twenty-five years of honest work at a large departmental store is expecting his promotion. Instead, he gets fired and then replaced by an adding machine which is capable of doing Mr. Zero's job faster and cheaper. Unable to cope with this unexpected change, he ends up murdering his boss. Mr. Zero is tried, convicted, and executed. After his death, Mr. Zero encounters three characters in the Elysian Fields, Shrdlu, Daisy, and Charles, and through them he realizes that by having chosen to live a submissive life, he had been trapped in a meaningless, thoughtless, and soul-deadening job. This musical comes to its pensive end with Mr. Zero being given a final chance to try again, although it's not clear if he'll do any better this time around.

The Scenery

The computer-generated imagery (CGI) for the virtual reality scenery in *Adding Machine* was produced and presented on a DELL Precision T3600 computer with the addition of a Quadro 6800 video card donated by the Nvidia Corporation. 3ds Max software from Autodesk was used to create the basic models for each scene. These models were then imported into Quest 3D software from the Act-3D company. In this virtual reality authoring program, various parts of the scenic models were given dynamic attributes, and other special effects were added. In this program, all the simulations for the various scenes were saved into a single runtime application. During performances this application was operated by a backstage crew member using the same computer connected to an Epson PowerLite 8300i projector located behind a full-stage rear projection screen.

For this production the relationship between the audience and the actors was turned 180 degrees from the usual configuration. The audience was seated on risers located at the rear of the rather large stage house. The rear projection screen was hung within the proscenium arch of the theatre and the rear screen projector was mounted on a platform out in the middle of the orchestra seating.

This was done for several reasons. First, this smaller seating configuration would condense the audience and ensure that they all had a prime viewing angle to the rear projection screen. More importantly, this arrangement allowed us to mount the FOH projectors, which would be doing the majority of stage lighting, in the stage house rigging where they had the most advantageous relationship to the stage. Furthermore, this seating configuration raised the audience up to a point where they would get a good view of the floor of the playing area where the

He realizes that by having chosen to live a submissive life, he had been trapped in a meaningless, thoughtless, and soul-deadening job

Figure 3. Zero in the afterlife with the iconic giant adding machine. Note the orbiting planets and ever present clock.

Figure 4. A conceptual sketch for the "Elysian Fields" Virtual reality technology is used to plan the production as well as execute the CGI scenography.

Figure 5. Zero and Daisy in the Elysium Fields. Note the live images of the chorus inserted into the scene. Also note the video footage of sunlight through trees most evident of the stage floor.

digital content being projected from the front of house instruments would show to its best advantage.

The CGI scenery for this show, in keeping with the style of the play, was decidedly surrealistic. Each scene projected onto the screen contained elements that were realistic but in a configuration or combination that fit the expressionist nature of the play (fig. 2). As the play progressed into scenes that were more fantastic in locale—the Elysian Fields, heaven, the reincarnation mechanism—the elements became more and more surreal and fantastic (fig. 3). This type of style is wonderfully suitable for CGI graphics, in which objects do not have to adhere to the laws of physics. Objects can float, grow, turn inside-out, or change color and texture at the direction of the backstage CGI operator. For example, as the racist and bigoted conversation at Mr. and Mrs. Zero's party escalates into the cast standing up and singing "My Country 'Tis of Thee," the wallpaper in the Zeros' apartment and the background of the New York tenements changes to a green and black and yellow version of American flags indicating the characters' warped version of the American dream. Later in the play, our version of paradise, the Elysian Fields, was filled with famous works of art. On cue with the music, the virtual canvases displaying Van Goghs, Manets, and Salvador Dalis, change to a live camera feed showing an offstage chorus singing haunting temptations to Mr. Zero (figs. 4,5 and 6).

The episodic nature of *Adding Machine* was also well suited to the use of virtual reality scenery. The many different locales of the play could appear before the audience in the blink of an eye rather than through the use of traditional scenic methods of shifting scenery, flying elements, turntables, etc. The only physical objects we shifted from scene to scene were a set of round stools, each painted like the keys of an adding machine that the actors brought with them or took away during entrances and exits (figs. 3, 5, and 6). The only other elements that figured in the shifting from scene to scene were minor costume changes. These were facilitated by having costume items such as jackets and hats located on coat trees on either side of the playing area. In all, the shifts from one scene to the next took all of three or four seconds.

One object or device that was common to each of the CGI scenes was a clock. The continual allusions to Mr. Zero's wasted life and the dramatic device of numbers throughout the play suggested that a variety of clocks appear within the scenes. Each clock was different in size and style, and each had a unique movement. Some clocks ran in almost normal fashion. Some, such as the clock in the execution room, moved very fast. On others, such as the one in his workplace, the hands move backwards. In some scenes the clocks had three or four hands, in others none at all (figs. 1 and 3)

The Lighting

The addition of digital projectors as key lighting instruments was the unique feature in this production that set it aside from previous experiments in CGI stagecraft. Our intent was to explore and communicate the inner worlds of the play's characters through the use of front projections which were cast over the performers and onto the floor throughout the production.

The projections used for lighting were comprised of both still images and looped animations. The animations came from several sources. Some were captured with a digital camera. Others, such as silent movies, were downloaded from sources on the web. Still others were created using 3-D modeling software, in our case Cinema 4D. These still images and animations were loaded onto two computers, one stage right and one stage left, and controlled using Isadora software from TroikaTronix. Isadora is a real-time video manipulation software that allows you to set up images and movie clips in a series of presets. It also allows you to manipulate the CGI images in a great variety of ways. Colors can be manipulated.

The size and shape of images can be customized. The speed and direction of animations can be slaved to movements of the mouse. Dozens of special effects can also be added, such as pixelation, size, position, textures, picture in picture, etc. During the running of the show the crew member assigned to either the stage right or stage left computer and projector combination (Apple iMac and Epson PowerLite 7700p) could flip from one pre-set to the next merely by pressing the space bar and using the mouse or keyboard to manipulate any special effects that had been added to that pre-set.

The front projections were mainly employed in three broad stylistic categories: expressionistic, stage illumination, and realistic. Each of these categories intersected with the needs of the script as well as those of the set and the lighting design during the production.

Utilization of projections as an expressionist device was visible during the pre-show and the first scene, where footage of 1920s America embellished the set and the actors' performances. Examples of this footage included silent movies, modernized transportation, glitz and glamour of New York's Manhattan, and people running, fighting, and attempting to catch up with this mad environment. Essentially, these images, shown in figure 2, are acknowledgements of Mrs. Zero's suppressed desires live a life similar to her friends, Mrs. Twelve and Mrs. Eight. She sings:

But when it comes to
me havin' a good time,
then it's always, "No!
I gotta start savin'," or "I
Ain't got the price!"
What about me?
Where do I come in
I wanna go downtown,
They go downtown all the time!

For scenes where Mr. Zero is relentlessly busy with adding numbers in either his job, his dreams, or his afterlife, computer-generated animations of numbers or dollar signs are projected onto the stage (fig. 1). These videos illustrated how much the fear of this new mechanical world, with its cruel and giant machines, has trapped Mr. Zero and has prevented him from rationally comprehending any facts.

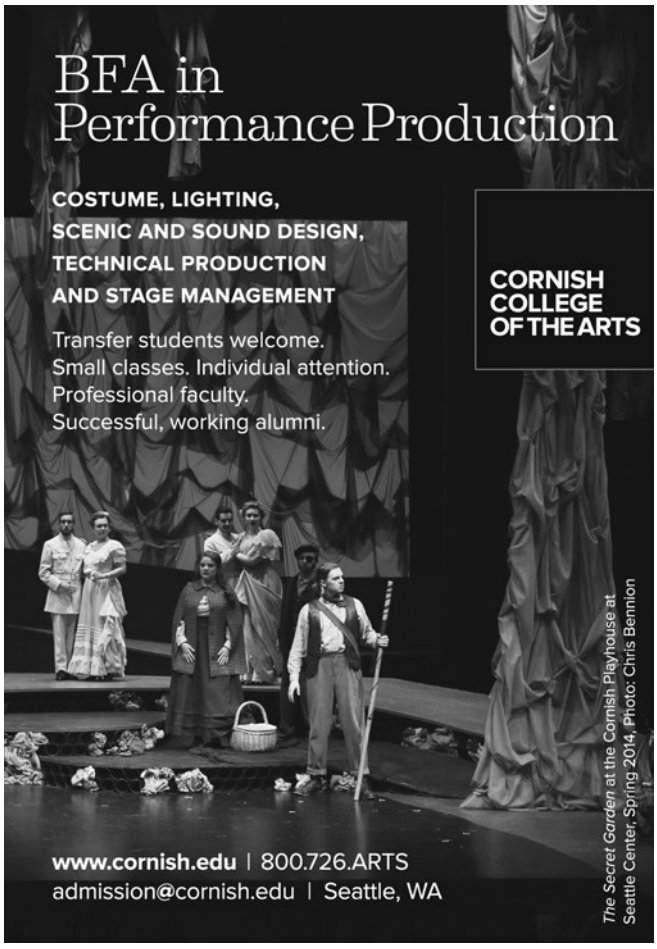
The videos and animations of numbers were also utilized in the courtroom scene, which can be regarded as a transition for Mr. Zero from his misery in this life to the possibility of something better in the afterlife. Here the video played a double role. On one hand, it illustrates the world into which Mr. Zero has sunk; his outrage during the confession scene is a powerful diatribe about the society and the world that has suppressed all of his desires, the world that has excluded him and has placed him in a dungeon such as an office for over twenty-five years to mechanically add numbers. On the other hand, the video metaphorically signals an unchangeable fact about Mr. Zero: he chooses to remain inferior to any dominant power and to bear the mark of his slavery on his back over and over again. He sings to the courtroom:

> The only physical objects we shifted from scene to scene were a set of round stools, each painted like the keys of an adding machine that the actors brought with them or took away during entrances and exits

I killed him!
But I'm a regular guy
Suppose you was me,
What would you do?
I'm like anyone else.
What would you do?

In terms of stage illumination, front projections functioned as front lights almost throughout the entire performance. In a few cases the projectors supplied a simple color

Figure 6. Zero and Daisy dancing in the Elysium Fields. Note the animation of artwork projected from the front that matches the scenic elements in the background.



The Secret Garden at the Cornish Playhouse at Seattle Center, Spring 2014. Photo: Chris Bennion

wash. During some scenes and for specific purposes, such as when we hear the inner thoughts of a character, the projectors served as follow spots. Examples were the office scene when Mr. Zero and Daisy start to sing and talk of their suppressed desires, or in prison and the final "Music of the Machine" scenes. These CGI follow spots were contrived through the use of a simple white circle on a black background. In the Isadora software, the computer operators were able to move the circle around the background and thereby control the "follow spot" through the use of the computer mouse.

The third category, realistic, served the needs of the script's special effects such as the police light in the party scene, light through the iron bars in the prison, or footages of wavering, dappled sunlight coming through the leaves in the Elysian fields. These videos were simultaneously projected on the actors and on the floor (figs. 5 and 6).

The front of house digital projectors did not provide all of the light for the production. In order to add dimensionality, a bit more color, and to ensure visibility, a minimal light plot was hung for the show. In all about twenty-five instruments were used. The small playing space facilitated this simple plot. In practice these additional lighting instruments were essential for softening or muting the digital effects. Lighting the scene with moving animations from the digital projectors alone often proved to be too distracting. While highlighting

the inner mindset of the characters, they often detracted from the actor's performance. Throughout the rehearsal process light cues were constantly being balanced between the digital sources and the more traditional ones.

All in all, the use of digital projectors was very successful. Given the right show and the consistent approach to all areas of design, this technology/technique can be a very effective part of the design concept. In terms of a realistic depiction of lighting effects, the moving images from a digital projector, such as dappled sunlight, can be much more convincing and mood evoking than can be achieved with the traditional gobo. Used as a replacement for intelligent lighting fixtures in applications such as a follow spot, a digital projector can be much more economical, easy to obtain, and portable. When used as a device to project inner thoughts and feelings of the show's characters, it is hard to beat. Anything that can be created on a computer screen can be projected onto the stage. The possibilities are nearly endless. Short of using dedicated software, any slideshow or PowerPoint presentation that fits a show's budget can be introduced into the scenography of a play. ❖

Rana Esfandiary *is a PhD student in the department of theatre at the University of Kansas. Her areas of research are Czech scenography and theatre for social change. She received her BA in playwriting from the University of Art, Tehran, in 2005 and her MFA in scenography from University of Kansas in 2013.*

Mark Reaney *is a professor and head of the scenography program at the University of Kansas. He received an MFA in scenic design from the University of Wisconsin-Madison. Mark's work on VR/Scenic Design has been featured in numerous texts, and in national and international exhibitions.*

The Institute for the Exploration of Virtual Realities (i.e. VR) maintains a website at www2.ku.edu/~ievr/ with information about its research, including pictures and videos from its experimental productions. Additionally, much of its work with virtual reality theatre has been chronicled in a series of articles in *TD&T* which are available in the Willard F. Bellman Digital Archives of TD&T at tdt.usitt.org.